TWO ELK ENERGY PARK

GEOPHYSICAL CHARACTERIZATION

The Upper Paleozoic to Mesozoic section can be divided in the TOEP into four reservoir-targeted storage complexes:

• The Speightshale-Hulet reservoir (200 m, 45% sand) and the Sandstone seal (20 m);
• The Minnelusa-Lakota reservoir (70%, 15% sand and the Fassett (12 m);
• The Dakota reservoir (11.4, 64% sand) and the large seal (1,500 m) on top of it.

Based on net sandstone thickness, average porosity, and CO2 density at the appropriate depths (pressure and temperature), the CO2 capacity of those complexes was calculated, using the equation $\rho_{\text{CO}_2} = \rho_{\text{N}_2}$ (NIST, 2011). Assuming storage efficiency, $E$, of 2%, the CO2 capacity is 0.13 MMt for the Minnelusa complex, 0.18 MMt for the Speightshale-Hulet complex, 0.08 MMt for the Minnelusa-Lakota complex, and 0.01 MMt for the Dakota complex.

Concentrations of dissolved-solids in ground water are between 3,000 to 10,000 ppm in the Paleozoic aquifers below Mesaverda, and in the Cenozoic aquifers in the lower Cretaceous aquifers (Lakota and Dakota formations). The Upper Cretaceous aquifer (Foot Hill and Hulett Creek formations) and the lower Dakota aquifer (Lakota Formation) have water salinity of less than 3,000 ppm (USGS, 1999). All of the remaining units between the saline aquifers (lower Cretaceous) and the fresh water of the Upper Cretaceous are more than 1,500 ft thick and are composed mostly of marine shale.

TOUGH2-ECON SIMULATION

We examine the storage of 0.2 kg of CO2 per meter for 30 years, followed by 400 years of post-injection monitoring stage, in the Lakota and Dakota formations, using TOUGH2-ECON numerical simulator. The Lakota and Dakota formations have the thickest sandstone layers, and their pore-water salinity is $>30,000$ ppm. The model is designed with refined grid near to the well, starting with 0.1 m and becomes coarser at increasing distance with a total of 34 gridblocks to reach 1,000 m. In the direction we use 1 m increment blocks. After 30 years of injection, a total mass of 15 Mt CO2 is stored in the model; 11.5 Mt in the Lakota Formation, 3.5 Mt in the Dakota Formation, and 0.4 Mt within the sealing units (Fassett and Sandstone formations). Post injection, 0.3 SC CO2 will be desorbed and trapped in aqueous phase. The loss of post-injection CO2 from the Lakota formation is an indication to the sealing ability of the Fassett formation. Even though CO2 migrates through the Mesaverda and Dakota formations (a clear breakthrough is evident in both sealing units after several hundred years of injection), there are several hundred meters of overlying units (not modeled here) that will contain the CO2.

CO2 STORAGE IN DEEP SALINE AQUIFERS IN THE TWO ELK ENERGY PARK TEST SITE, POWDER RIVER BASIN, WYOMING: GEOPHYSICAL CHARACTERIZATION AND CAPACITY ESTIMATION

This work is supported by the DOE Fossil Energy CO2 Site Characterization program through a contract with the National American Power Group.

CO2 STORAGE CAPACITY ESTIMATE

The two Elk Energy Park (TEEP) is a commercial-scale demonstration project, co-funded by DOE and North America Power Group. The project is located in the Powder River Basin, northeastern Wyoming and planned as a series of multiple renewable and other electric power generation and carbon capture and sequestration facilities. TEEP lies directly on top of several saline aquifers, depleted oil-bearing paystones, and coal seams. The Powder River basin, particularly in the TEEP vicinity, was identified by the NITS and BSCF as one with “high potential” for large-scale sequestration project. BSCF estimate storage in deep saline formation of up to 156 Gt CO2 (NITS, 2009). A high of CO2 for 30 years is the current storage goal for the project.

The Powder River Basin is an elongated (150 by 350 km) structural basin, bounded by the Big Horn Mountains and Casper Arch on the west, Mills City Arch to the north, Black Hills uplift to the east, and the Harney uplift and Laramie Mountains to the south, located in northeast Wyoming and eastern Montana. During the Paleozoic time (Mississippian), the Powder River basin was part of the paleo-Williston Basin. The present topography of the basin is the result of Late Cretaceous and Early Tertiary deformation (Laramide orogeny). The entire sedimentary fill in the basin is approximately 4,500 m. TEEP is located on the gently sloped (1°) to the southeast) side of the basin. Few regional aquifer systems, with variable salinities, are known in the basin (USGS, 1996).

Powder River Basin was located at the central part of the Mid-Cretaceous marine seaway. Deep marine chert continued to be deposited in the deep basin, while during regression or desertification, marine water was deposited in the basin. The shale units consist of Fuson Shale, Mossey, and Minnelusa formations, while the sand units are the Dakota, Muddy, Frontier, Mesaverda, and Lance formations. The Fusion Formation (60 m) is a marine shale unit. The lower (14 m) unit, the Dakota Formation (76 m), is comprised mostly of sandstone (net sand 34 m) with log-porosity of about 10%.

Bibliography

10th ANNUAL CARBON CAPTURE & SEQUESTRATION CONFERENCE May 2-5, 2011, Pittsburgh, Pennsylvania

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